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L5: Entry 1 of 2 File: DWPI Jul 19, 2001

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DERWENT-WEEK: 200172

TITLE: Magnetic recording medium for video tape recorder, magnetic disc unit, has carbon film consisting of nitrogen and fluorine atoms

PATENT-ASSIGNEE:

ASSIGNEE	CODE
MATSUSHITA DENKI SANGYO KK	MATU

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INT-CL (IPC): G11 B 5/72; G11 B 5/84

ABSTRACTED-PUB-NO: JP2001195723A
BASIC-ABSTRACT:

NOVELTY - The magnetic recording medium has lubricant layer (4), carbon film (3) and ferromagnetic metal thin film (2) as magnetic layer sequentially on non-magnetic substrate (1). The carbon film consists of nitrogen and fluorine atoms.

DETAILED DESCRIPTION - An INDEPENDENT CLAIM is also included for manufacture of magnetic recording medium. After forming magnetic recording layer, a mixed gas containing hydrocarbon group gas, fluorine gas and nitrogen gas are supplied and carbon film containing nitrogen and fluorine is formed by plasma chemical vapor deposition.

USE - For video tape recorder, magnetic disc unit.

ADVANTAGE - Since fluorine atom is contained in addition to nitrogen atom, the durability of the magnetic recording medium is improved.

DESCRIPTION OF DRAWING(S) - The figure shows sectional drawing of magnetic recording medium.

Non-magnetic substrate 1

Ferromagnetic metal thin film 2

Carbon film 3

Lubricant layer 4

CHOSEN-DRAWING: Dwg.1/2

TITLE-TERMS: MAGNETIC RECORD MEDIUM VIDEO TAPE RECORD MAGNETIC DISC UNIT CARBON FILM

CONSIST NITROGEN FLUORINE ATOM

DERWENT-CLASS: L03 T03

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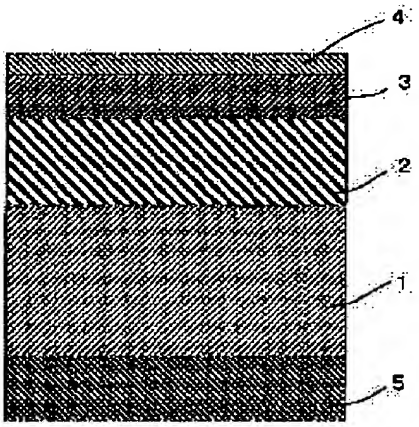
(71)Applicant : **MATSUSHITA ELECTRIC IND CO LTD**
(72)Inventor : **NISHIZAWA YASUHIRO**
MORITA TAKESHI

(54) MAGNETIC RECORDING MEDIUM AND METHOD FOR PRODUCING SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To suppress the wear of a head by a magnetic recording medium as well as to enhance the traveling durability of the magnetic recording medium.
SOLUTION: The magnetic recording medium has a ferromagnetic metallic thin film formed as a magnetic layer on the nonmagnetic substrate, a carbon film formed on the metallic thin film and a lubricant layer formed on the carbon film. The carbon film contains nitrogen and fluorine atoms.



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* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The magnetic-recording medium which is a magnetic-recording medium which has the lubricant layer formed on the ferromagnetic metal thin film formed as a magnetic layer on the nonmagnetic substrate, the carbon film formed on the ferromagnetic metal thin film, and the carbon film, and is characterized by a carbon film changing including a nitrogen atom and a fluorine atom.
[Claim 2] The magnetic-recording medium according to claim 1 whose ratios (B/A) of the peak intensity (A) which the peak existed in the 1550cm-1 neighborhood in the Raman spectrum about a carbon film, and deducted the peak intensity (B) and background are 1.2-10.
[Claim 3] The magnetic-recording medium according to claim 1 or 2 whose atomic ratios of a fluorine to the carbon in a carbon film are 0.01-0.15.
[Claim 4] A magnetic-recording medium given in any 1 term of the claims 1-3 whose atomic ratios of nitrogen to the carbon in a carbon film are 0.1-0.6.
[Claim 5] A magnetic-recording medium given in any 1 term of the claims 1-4 whose atomic ratios of nitrogen to the oxygen in a carbon film are 1.0 or more when a carbon film contains oxygen.
[Claim 6] The manufacture method of the magnetic-recording medium which enforces the plasma CVD method which makes material gas the mixed gas containing hydrocarbon system gas, nitrogen distributed gas, and fluorine distributed gas after forming a magnetic layer in one nonmagnetic substrate side, and includes the process which forms the carbon film containing a nitrogen atom and a fluorine atom on a magnetic layer.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention is a ferromagnetic metal thin film type magnetic-recording medium used for VTR, a magnetic disk unit, etc., and relates to the magnetic-recording medium which formed the carbon film which has predetermined composition as a protective layer on the magnetic layer which is a ferromagnetic metal thin film, and its manufacture method.
[0002]
[Description of the Prior Art] In recent years, in the field of magnetic recording, large-capacity-izing, improvement in the speed, high definition and quality[of loud sound]-izing, small lightweight-ization, etc. are demanded, and development and utilization of the ferromagnetic metal thin film type magnetic-recording medium suitable for high-density record are recommended positively to meet this request. this magnetic-recording medium is recordable high-density -- in addition, it is desirable that it is what it has what] that practical use reliability is high, i.e., the outstanding run stability, endurance, corrosion resistance, weatherability, etc., and does not wear the head of record and a regenerative apparatus
[0003] Then, a ferromagnetic metal thin film (2) is formed in a nonmagnetic substrate (1) as a magnetic layer, a carbon film (3) and a lubricant layer (4) are formed on the ferromagnetic metal thin film (2) concerned at this order, and the common magnetic-recording medium has the composition that a carbon film (3) protects a magnetic layer (2), as typically shown in drawing 1 . With the field in which the ferromagnetic metal thin film (2) of a nonmagnetic substrate (1) is prepared, in order to raise the run stability of a magnetic-recording medium, a back-coat layer (5) is formed in the field of an opposite side.
[0004] A carbon film (3) has big influence on the practical use reliability of the whole magnetic-recording medium as a protective layer of a magnetic layer (2). Then, various proposals are made about the composition and formation method to obtain the more excellent protective effect. For example, in order to raise abrasion resistance and corrosion resistance, forming the diamond-like carbon film which cannot be easily worn out due to a high degree of hardness on a magnetic layer is proposed in many reference, such as JP,61-210518,A and JP,63-98824,A.
[0005] Moreover, forming the diamond-like carbon film containing the nitrogen atom on a magnetic layer improving run stability and endurance further is proposed in JP,8-124149,A, JP,11-39647,A, etc. The thing in which the carbon film which contained the nitrogen atom at a predetermined rate was formed on the surface of the carbon film is also proposed.
[0006]
[Problem(s) to be Solved by the Invention] According to the carbon film containing a nitrogen atom, a protective layer with a high degree of hardness can be formed. However, for example, since the carbon film of the SP3 joint subject in which a nitrogen atom is contained at a rate of 0.05-0.2 to a carbon atom has the membranous high degree of hardness, head wear may be increased. Moreover, since a stiff film tends to exfoliate easily, the endurance of a magnetic-recording medium may be reduced on the contrary. When the carbon film which contains a nitrogen atom at a predetermined rate on the surface of a carbon film is formed, the bonding strength between a carbon-film front face and a lubricant layer has the problem that degradation advances rapidly, when it begins to wear a carbon-film front face out, although increased. Thus, each conventional carbon film was what requires the further improvement.
[0007] this invention is made in view of this actual condition -- having -- electromagnetism -- while raising the endurance of a magnetic-recording medium, without having a bad influence on the transfer characteristic, let it be a technical problem to offer a magnetic-recording medium with the high practical use reliability which has the carbon film which can make small head wear at the time of use, and changes
[0008]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention is a magnetic-recording medium which has the lubricant layer formed on the ferromagnetic metal thin film formed as a magnetic layer on the nonmagnetic substrate, the carbon film formed on the ferromagnetic metal thin film, and the carbon film, and offers the magnetic-recording medium characterized by a carbon film changing including a nitrogen atom and a fluorine atom. A carbon film is prepared in order to protect a magnetic layer, and it gives run stability, endurance, corrosion resistance, etc. to a magnetic-recording medium. A fluorine atom improves the protection feature of the carbon film containing a nitrogen atom, and it suppresses head wear effectively while raising the endurance of a magnetic-recording medium more. Although it is thought that a carbon film is soft and this effect is brought about by the bird clapper by existence of a fluorine atom, this presumption does not restrain this invention at

all.

[0009] In this invention, in the Raman spectrum about a carbon film, a peak exists in the 1550cm-1 neighborhood, and it is desirable that the ratios (B/A) of the peak intensity (B) and the peak intensity (A) which deducted the background are 1.2-10. An example of the Raman spectrum about the carbon film which constitutes the magnetic-recording medium of this invention in drawing 2 is shown. Here, peak intensity (B) means the height from BURANKUREBERU in a peak point to a peak point. The background is equivalent to the imaginary line (it expresses as a dashed line among drawing) which connected the spectrum before and behind a peak, and the peak intensity (A) which deducted the background means what deducted the height from BURANKUREBERU in a peak point to the background from peak intensity (B).

[0010] In the Raman spectrum about a carbon film, the peak of the 1550cm-1 neighborhood shows that diamond combination exists in a carbon film. B/A of the 1550cm-1 neighborhood is one of the indexes of the degree of hardness of a carbon film, when this value is small, its degree of hardness of a carbon film increases, and it makes head wear increase, and if this value is large, a film will become soft, and cannot give sufficient endurance for a magnetic-recording medium, but makes coefficient of friction of the magnetic-recording medium after carrying out a repeat run increase. In this invention, while securing a moderate degree of hardness, as for B/A, it is desirable that it is within the limits of the above to make head wear small.

[0011] As for the atomic ratio of a fluorine to the carbon in a carbon film, it is desirable that it is 0.01-0.15. In exceeding 0.15, while a carbon film becomes hard too much in being less than 0.01, and a carbon film becomes soft, the adhesion force with a ferromagnetic metal thin film declines. Coefficient of friction of the magnetic-recording medium after it reduced the endurance of a magnetic-recording medium in any case and it carried out the repeat run is increased.

[0012] As for the atomic ratio of nitrogen to the carbon in a carbon film, it is desirable that it is 0.1-0.6. If the rate for which a nitrogen atom accounts is small, the bond strength to the carbon film of a lubricant layer may fall, and the fall of endurance may be caused. Problems, like gas advances from the portion in which the continuity of a carbon film will be spoiled if the rate for which a nitrogen atom accounts is large, a magnetic layer cannot fully be protected, for example, carbon does not exist, and rust arises in a magnetic layer may be caused.

[0013] Moreover, when a carbon film contains an oxygen atom in this invention in addition to a fluorine atom and a nitrogen atom, being contained in a carbon film is desirable [a nitrogen atom] so that the atomic ratio of nitrogen to the oxygen in a carbon film may become 1.0 or more. There are few contents of the nitrogen atom in the carbon film of a magnetic-recording medium than the content of an oxygen atom, namely, if there are many rates for which an oxygen atom accounts to a carbon film, coefficient of friction of the magnetic-recording medium after carrying out a repeat run will tend to increase, and it will become difficult to obtain the magnetic-recording medium which has sufficient endurance.

[0014] After such a magnetic-recording medium forms a magnetic layer in one nonmagnetic substrate side, it enforces the plasma CVD method which makes material gas the mixed gas containing hydrocarbon system gas, nitrogen distributed gas, and fluorine distributed gas, and can manufacture it preferably by the manufacture method including the process which forms the carbon film containing a nitrogen atom and a fluorine atom on a magnetic layer. A plasma CVD method is the formation method of the carbon film adopted in conventionality. In the manufacture method of this invention, it is using the mixed gas which contains nitrogen distributed gas and fluorine distributed gas as material gas, and has secured that a nitrogen atom and a fluorine atom are contained in a carbon film.

[0015] 1-15% F

[Embodiments of the Invention] Hereafter, the concrete gestalt of this invention is explained. The magnetic-recording medium of this invention has the feature at the point that a carbon film has a nitrogen atom and a fluorine atom. the atomic ratio of a fluorine to carbon [in / a carbon film / in a fluorine atom] -- desirable -- 0.01 to 0.15 -- it is contained in a carbon film so that it may be more preferably set to 0.05-0.15 moreover, the atomic ratio of nitrogen to carbon [in / a carbon film / in a nitrogen atom] -- desirable -- 0.1 to 0.6 -- it is contained in a carbon film so that it may be more preferably set to 0.15-0.4

[0016] Furthermore, in the magnetic-recording medium of this invention, in the Raman spectrum about a carbon film, a peak exists in the 1550cm-1 neighborhood, and it is desirable that the ratios (B/A) of the peak intensity (B) and the peak intensity (A) which deducted the background are 1.2-10. As for B/A, it is more desirable that it is 1.3-5.

[0017] Moreover, when oxygen is further contained in a carbon film in addition to a fluorine atom and a nitrogen atom, as for the atomic ratio of nitrogen to the oxygen in a carbon film, it is desirable that it is 1.0 or more. Although not existing in a carbon film is desirable as for an oxygen atom, generally in the carbon film formed by the plasma CVD method, oxygen is contained unescapable. The oxygen atom in a carbon film deteriorates a carbon film, and is considered to have the influence which is not desirable on the endurance of a magnetic-recording medium. Therefore, while it is shown that having specified the atomic ratio of nitrogen to oxygen as mentioned above can choose the rate of the nitrogen atom occupied in a carbon film also in a relation with the content of oxygen, it is shown that it is also necessary to restrict the content of the oxygen atom in a carbon film.

[0018] A carbon film makes hydrocarbon system gas a principal component, and can form it by the plasma CVD method for specifically carrying out the gas which supplies nitrogen, nitrogen content gas and the gas which supplies a fluorine, and the thing which specifically mixed fluorine content gas as material gas. A carbon film is formed on the ferromagnetic metal thin film which is the magnetic layer beforehand formed on the nonmagnetic substrate. As nitrogen content gas, there are nitrogen gas and ammonia and there are CF4 which is a fluorocarbon, for example, and C2F6 as fluorine content gas, for example. Hydrocarbon system gas may usually be used, when forming the carbon film of a magnetic-recording medium by the plasma CVD method, and methane, ethane, a propane, butane, a pentane, a hexane, a heptane, an octane, benzene, or toluene can be used for it. Inert gas, such as an argon, a xenon, and a krypton, may be further contained in material gas if needed.

[0019] Specifically, formation of the carbon film by plasma CVD is carried out by introducing material gas into a reaction container, generating electric discharge inside a reaction container, where the pressure in a container is kept at 0.13-130Pa, and generating the plasma of hydrocarbon system gas. Hydrocarbon system gas, fluorine content gas, and nitrogen content gas are introduced into a reaction container by the predetermined flow rate during formation of a carbon film, respectively, and they are mixed in a reaction container. If the amount of supply (for example, flow rate) of each gas is changed, the composition ratio of the fluorine atom in a carbon film and a nitrogen atom is changeable. When using toluene, specifically using nitrogen gas as nitrogen content gas as hydrocarbon system gas and using CF4 as fluorine content gas, the carbon film which contains a fluorine atom and a nitrogen atom for the ratio of a flow rate at about 4= 1:4 to 12:0.05 to 0.6 toluene:nitrogen:CF, then an above-mentioned desirable rate can be formed.
[0020] Any of an external electrode method and an internal-electrode method are sufficient as electric discharge form, and electric discharge frequency can be decided experimentally. B/A can be changed by changing the voltage impressed in the case of electric discharge. Usually, if voltage is large, B/A will become small, and B/A will tend to become large if voltage is small. B/A may be changed also by changing the pressure of material gas again.
[0021] In this invention, in order to secure the reproduction output in a short wavelength field, as for a carbon film, it is desirable to form so that it may become the thickness of 3-20nm. In case the thickness of a carbon film forms a carbon film, it may be suitably changed by changing the bearer rate of the object (namely, nonmagnetic substrate in which the magnetic layer was formed) to which a carbon film is made to adhere.
[0022] If the magnetic-recording medium of this invention removes a point making it be the above [the composition of a carbon film], it is the same as the conventional magnetic-recording medium. therefore, the cross section is shown in drawing 1 -- as -- a ratio -- it becomes the composition that the ferromagnetic thin film (2), the carbon film (3) as a protective layer, and lubricant layer (4) which are a magnetic layer were formed in one field of a magnetic substrate (1) at this order, and the back-coat layer (5) was formed in the field of another side of a nonmagnetic substrate (1)
[0023] Portions other than a carbon film (3) which constitute the magnetic-recording medium of this invention can use for and form a conventional material and a conventional method.
[0024] For example, a film, an aluminum substrate, or a glass substrate etc. which consists of a polyethylene terephthalate, polyethylenenaphthalate, a polyamide, or a polyimide can be used as a nonmagnetic substrate (1).
[0025] The ferromagnetic metal thin film (2) which is a magnetic layer is formed in ferromagnetic metals, such as Co, Fe, and nickel, and a row with the material by which **** selection is carried out from alloys, such as Co-nickel and Co-Cr. A ferromagnetic metal thin film (2) can be formed by the ion plating method, the sputtering method, or the vacuum deposition method that used the electron beam. Vacuum deposition may use for and enforce the method vacuum deposition of slanting which the incident angle of a metallic-fumes style is changed continuously, and carries it out. If needed, a ferromagnetic metal thin film (2) introduces oxygen slightly, and forms it in a vacuum tub (or reduced pressure tub), and oxygen may be made to be contained with the gestalt of a metallic oxide (for example, CoO) in a ferromagnetic metal thin film (2). The thickness of a ferromagnetic metal thin film (2) has common 50-300nm.
[0026] As for the lubricant which constitutes a lubricant layer (4), it is desirable that it is the fluorine-containing hydrocarbon system compound which introduced polar groups, such as a carboxyl group, into the molecule. A lubricant layer (4) can be formed by the wet applying method to dry after applying the application liquid which dissolved in the suitable solvent and prepared lubricant on a carbon film (3). You may form a lubricant layer (4) by the organic vacuum deposition.
[0027] A back-coat layer (5) is formed of one or two or more material which are chosen from a polyurethane resin, a nitrocellulose resin, polyester resin, carbon black, a calcium carbonate, etc. A back-coat layer (5) can be formed by drying a solvent, after applying to a nonmagnetic substrate (1) the application liquid which made the suitable solvent dissolve or distribute such material. As for the thickness of a back-coat layer (5), being referred to as about 0.5 micrometers is desirable.
[0028]
[Example] Next, although the concrete example of this invention is explained, this invention is not limited to this example.
[0029] (Samples 1-15) The polyethylene-terephthalate film with a thickness of 7 micrometers was prepared as a nonmagnetic substrate (1). One field of this film (1) was made to carry out the vacuum evaporationo of the Co under oxygen atmosphere, and the ferromagnetic metal thin film (2) with a thickness [containing cobalt oxide] of 180nm was formed in it. Vacuum evaporationo changed the vacuum evaporationo incident angle continuously, and carried it out.
[0030] The back-coat layer (5) was formed in the field of another side of a polyethylene-terephthalate film (1) after vacuum evaporationo. The back-coat layer (5) was formed by the wet applying method using polyester resin and carbon, and it was formed so that the thickness after dryness might be set to about 0.5 micrometers.
[0031] Next, plasma CVD equipment was used for the front face of a ferromagnetic metal thin film (2), and the carbon film (3) was formed in it. The formation conditions of a carbon film (3) are as follows.
[0032] Material gas: What mixed nitrogen gas as nitrogen distributed gas, and mixed the tetrafluoromethane (CF4) as fluorine content gas was used for the mixed gas of toluene and an argon. In this example, each gas is introduced independently into a reaction container by the predetermined flow rate, and they were mixed in the reaction container. In order to change the composition ratio of the fluorine atom in a carbon film, and a nitrogen atom, the flow rate of each gas was suitably changed for every sample, as shown in Table 1. When the carbon film which does not contain a fluorine atom was formed, the flow rate of CF4 was made into zero, and when the carbon film which does not contain a nitrogen atom was formed, the flow rate of nitrogen gas was made into zero.

[0033] Reaction pressure: It could be 27Pa.
[0034] Applied voltage: The fixed voltage which is within the limits of 0.8-2.5kV using DC power supply was impressed. In order to change the peak intensity ratio (B/A) of a Raman spectrum, applied voltage was suitably changed for every sample, as shown in Table 1.
[0035]
[Table 1]

試料	ガスの流量(cm³／分)			印加電圧(kV)
	トルエン	窒素	フロン	
1	20	100	5	2. 0
2	20	100	10	1. 5
3	20	200	5	2. 0
4	20	100	2	1. 0
5	20	100	7	1. 2
6	20	150	0	2. 0
7	20	0	2	2. 0
8	20	100	30	1. 2
9	20	300	20	1. 2
10	20	20	5	1. 5
11	20	150	2	2. 5
12	20	100	5	0. 8
13	20	100	15	1. 5
14	20	100	5	2. 5
15	20	100	2	2. 0

[0036] The elementary composition of the carbon film of each sample was analyzed by X-ray photoelectron spectroscopy, and it asked for the atomic ratio (N/O) of nitrogen to the atomic ratio (N/C) and oxygen of nitrogen to the atomic ratio (F/C) of a fluorine to the carbon in a carbon film, and carbon. Moreover, about each sample, Raman spectroscopic analysis of a carbon film was carried out and it asked for the peak intensity ratio (B/A) of the peak of the 1550cm-1 neighborhood from the acquired spectrum. The obtained result is shown in Table 2.
[0037] Next, on the surface of the carbon film (3), by the wet applying method, the lubricant layer (4) which consists of a fluorine-containing carboxylic acid (C5F 11 (CH2) 10COOH) was formed so that the thickness after dryness might be set to about 4nm.
[0038] The tape material produced as mentioned above was judged to 8mm width of face by the slitter, and the magnetic tape for 8mmVTR was produced.
[0039] 8mmVTR (EVS[by Sony Corp.]- 900) was equipped with the obtained magnetic tape for 8mmVTR(s), in the environmental tub of 40-degree-C80%RH, 300 ****s of repeat runs were carried out and the abrasion loss of the thickness direction of the head after a run was measured.
[0040] Moreover, before carrying out a repeat run, coefficient of friction of a magnetic layer side front face was measured about the magnetic tape after carrying out. coefficient of friction -- each sample -- a friction member (the product made from stainless steel (SUS420J2, surface roughness 0.2S) --) Twist around a friction member at 90 degrees of contact angles with an outer diameter of 6mm, on tension 0.2N conditions, begin to roll a sample, and begin to wind, and carry out both rolling-up speed in 14mm/second, and a tension is measured to a rolling-up side. It began to wind, and calculated and asked from the formula of an oiler from the ratio with a near tension.
[0041] Coefficient of friction before and behind implementation of a run is repeatedly shown in Table 2 at F/C of the carbon film of samples 1-15, N/C and N/O, a peak intensity ratio (B/A), the evaluation result of head wear, and a row, respectively.
[0042]
[Table 2]

試料	X線光電子分光			ピーク強度比	ヘッド摩耗	摩擦係数	
	F/C	N/C	N/O	B/A	(μm)	走行前	走行後
1	0.02	0.2	1.2	1.5	1～2	0.22	0.25
2	0.05	0.16	1.1	2.5	1～2	0.2	0.24
3	0.02	0.5	2.3	1.8	1～2	0.22	0.24
4	0.01	0.21	1.1	9.4	1～2	0.22	0.29
5	0.03	0.22	1.25	4.8	1～2	0.22	0.26
6	0	0.26	1.2	2.2	1～2	0.26	0.35
7	0.01	0	0	1.8	1～2	0.22	0.48
8	0.2	0.2	1.2	6.5	3～4	0.23	0.4
9	0.15	0.7	3.5	4.5	5～7	0.23	0.4
10	0.02	0.05	0.1	3.2	1～2	0.21	0.33
11	0.01	0.27	1.3	1.15	4～5	0.2	0.22
12	0.02	0.18	1.2	12.4	1～2	0.21	0.45
13	0.08	0.14	0.82	3.8	1～2	0.23	0.38
14	0.02	0.16	0.97	1.2	3～4	0.22	0.24
15	0.01	0.18	0.42	1.8	1～2	0.22	0.42

[0043] Even if each magnetic tape (samples 1-5) in which a nitrogen atom is contained so that a fluorine atom may be contained so that F/C may be set to 0.01-0.15 into a carbon film, and N/C may be set to 0.1-0.6 and N/O may become 1.0 or more from Table 2 carries out a repeat run, it does not produce wear of a head so much. Moreover, coefficient of friction smaller [the increase in coefficient of friction is also small, and] than 0.3 after carrying out a repeat run was maintained. This shows that these magnetic tapes are excellent in endurance.

[0044] The magnetic tape (sample 6) by which a fluorine atom is not contained in a carbon film had the large increase in coefficient of friction after carrying out a repeat run, and it was what is inferior in respect of endurance. Moreover, the measurement result of coefficient of friction of a sample 7 shows that the magnetic tape in which a carbon film does not contain a nitrogen atom is inferior in respect of endurance. These show that the nitrogen atom and fluorine atom which are contained in a carbon film are raising the protection feature of a carbon film in multiplication.

[0045] About the magnetic tape (sample 8) with larger F/C than 0.15, head wear was a little large, and it was not what can be satisfied also in the point of endurance. Since head wear became large since the carbon film which ablation arose in the carbon film and exfoliated in it during the run gave the damage to the head in the magnetic tape (sample 9) with larger N/C in a carbon film than 0.6, and the carbon film exfoliated and the protective layer was lost, the magnetic tape concerned was inferior also in respect of endurance. As for the magnetic tape (sample 10) with N/C smaller than 0.1 in a carbon film, coefficient of friction after carrying out a repeat run exceeded 0.3, and endurance was what a little inferior.

[0046] The abrasion loss of a head is large and the evaluation result of head wear of a sample 11 shows a bird clapper, when the peak intensity ratio (B/A) of the peak of the 1550cm-1 neighborhood in the Raman spectrum about a carbon film uses the magnetic tape which is 1.2 or less. Moreover, the measurement result of coefficient of friction of a sample 12 shows that it is inferior in respect of endurance, when this peak intensity ratio (B/A) becomes ten or more.

[0047] Even when there are F/C and N/C within desirable limits, the magnetic tape (samples 13-15) whose atomic ratio of nitrogen to the oxygen in the carbon film of a magnetic tape is one or less wears a head, or is in the inclination for coefficient of friction after a repeat run to become large. This will have suggested that it is in the inclination for the protection feature of a carbon film to fall, if the rate for which the oxygen atom in a carbon film accounts becomes larger than a nitrogen atom.

[0048]

[Effect of the Invention] As explained above, the magnetic-recording medium of this invention is characterized by the carbon film containing a fluorine atom in addition to a nitrogen atom. According to this feature, the magnetic-recording medium of this invention becomes that whose endurance could not wear out easily in a head and improved compared with that by which only a nitrogen atom is contained in a carbon film. Furthermore, reduction of head wear and improvement in endurance can be aimed at more by forming a carbon film, as the peak intensity ratio of the 1550cm-1 neighborhood in the Raman spectrum about a carbon film is in predetermined within the limits.

[0049] In this invention, as the atomic ratio of the fluorine to the carbon in a carbon film and nitrogen is in predetermined within the limits, when it optimizes composition of carbon, nitrogen, and a fluorine, good endurance etc. is given to the magnetic-recording medium. Moreover, the content of a nitrogen atom can be further optimized by specifying the atomic ratio of nitrogen to oxygen, and, thereby, the protection performance of a carbon film may improve further. Therefore, the magnetic-recording medium of this invention presents the practical use reliability which it has sufficient endurance to a run of a repeat with 10nm or less even if the carbon film which constitutes it is very thin, and was excellent in it.

[Translation done.]